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# A Study on Clustering and Hierarchical Routing Based Protocols in Wireless Sensor Network

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***Abstract—Wireless sensor network (WSN) is gathering of wireless nodes which are casually being transferred in an area which is targeted done the dynamically shifting the situations. Such nodes may beintelligence, procedure, and onwardin formation towards the nodes of neighboring size & base station (BS). Besides, such devices of minor size are restricted by the proficiencies likeless memory, calculation of low form, low processing, & much importantly small form of the power unit (generally being equipped by the batteries). The sensor nodes being distributed do nehugeenviron mental field comprising nodes of hundreds formtowards monitor the goal district. For example sensed information being towards be sentso as towards BS aimed at the additional essential action, so routing forms necessary aimed atonly transmitting of the in formation after node towards node or the BS proficiently. In schemes of clustering hierarchicalform have gained excessive attention aimed at energy ingestion minimizing. Hierarchical systems being normally considered cluster-based & grid-based methods. In cluster-based methods, nodes are assembledin form of clusters, where a sensor node resourceful being selected like cluster head (CH) although in grid-based method network (NW) is split in restricted simulated grids generally executed through BS.***

***Keywords—WSN, Cluster, Cluster head, Routing protocol, Hierarchical protocol, Grid-based cluster head.***

## I. INTRODUCTION

A WSN is an NW with gathering the sensor nodes which are interconnected by wireless medium or wireless communication channels. The data is collected from the surrounding area by each sensor node which is actually acting as a small device, as illustrated earlier.

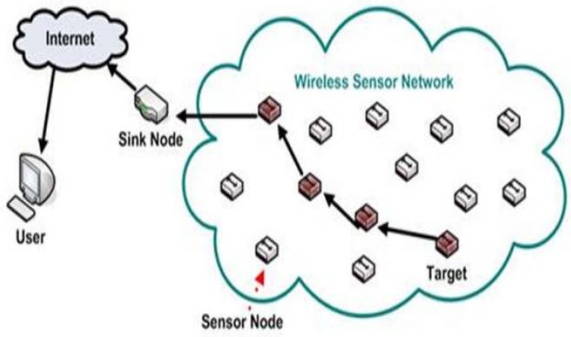


Fig.1 Wireless Sensor Network Architecture [2]

It also communicates using further sensors nodes or using the BS and carries out simple computations as well. The sensor nodes are generally organized into a specific county to monitor & detect real-time environmental activities and are capable of information gathering & transmission towards BS/sink. BS/sink may connect to the end user or task manager node by means of the Internet or satellite. Structure of the sensor system is impacted through many apparatuses, including variation toward sinterior failure, adaptability, generation expenses, working circumstance, sensor arrange topology, transmission media & power-utilization [1].

## II. CLUSTERING IN WSN

Because of rare resources into WSN, direct transmission of sensor nodes with BS or multi-hop transmission of sensor nodes towards BS is not accessiblelike energy consumption is great which outcomes intothe quickend of sensor hubs Figure 2.

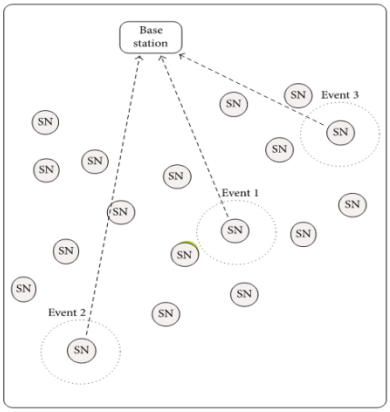


Fig.2 Direct Communication

Since the WSN cannot increase its entire deal correspondence, direct correspondence or single-level correspondence is not possible for large-scale organizations. Direct correspondence has its drawbacks, for example, greatvigor usage, replication of information (sensor hubs that are adjacent to each other), transferinformationby exceptionally little variety), &maximum distant hubs kicking the bucket rapidly. To beat these issues, two-level correspondence through various leveled approach is used where hubs are gathered into bunches. Pioneer hub likewise known as CH is intothe charge of collecting the data&when that transfer it towards BS.

A.*Advantages of clustering*:
1. Decreaseaboveaimed atinformation transmission in clustering NW topologies.
2. Routing time-consuming low memory in the sensor node.
3. It delivers bandwidth (BW) reusability &decreases conflict of channels.
4. Increases the solidity of the NW because ofthe low use of power through the cluster.
5. Maintain routing on the cluster head networks of only a few nodes and gateway nodes.
6. Increase networklifetime.

## III. CLUSTERING ROUTING PROTOCOLS

Routing algorithms are finding a path between nodes through in source to destination. Routing algorithm with clustering used for less energy consumption and optimal use of resources. It provides a reliable route for transmission of data through source node to base station. In clustering network divided into several parts and each part is clustered as a cluster. Clusters are clusters of nodes & one of the nodes is beingchosenlike theCHproceedingbasis of parameters CH performs information integration or data synthesis on the signal obtained before forwarding the base station. Clustering reduces the load to increase the network lifetime. It provides several advantages during routing as scalability, reduces load, energy consumption [9].

There exist various advantages in clustering routing algorithms associatedwith the flat routing ones intoWireless Sensor Networks. The main advantages of clustering routing algorithms are surveyed as follows.

A. Increase of Scalability: Inclustering routing form ofsystem, sensor hubs are separated in an assortment of the clusters using various task stages. The cluster heads (CHs) are in charge of information accumulation, data scattering and system the board, and the part hubs for occasions detecting and data collecting intothe environment. Clustering topology controls the course system inside the cluster & hence decrease the scope of directing table put away onspecific sensor hubs. Contrasted and level topology, this sort of system topology is simpler for board, and increasingly adaptable to react to occasions in nature.

B Decrease of Load: aimed at clustering topology, altogether cluster members simply transferrin formation towards cluster heads (CHs), & information accumulation is executed on the CHS, which support towards in tensely decrease transmission information & save energy. In accumulation, the methods are set up inside the clusters which thus decrease the extent of the routing table kept at the discrete sensor nodes.

C. Improvement of power: contrasted and flat routing technique, clustering routing plan creates it progressively helpful aimed at system topology influence & reacting to NW modifications containing hub expanding, hub movability & unexpected failures, & so forth. Clustering routing scheme just wants towards acclimating near these development sintimate distinct clusters, accordingly, the complete system is increasingly emphatic & progressively helpful aimed at the executives.

D. Alleviation of Collisions: Clustering routing scheme is clustered into WSN clusters and consists of two modes, such as inter-clusters and inter-clusters, to collect data communications between sensor nodes and to disseminate information respectively. Cluster heads only help to avoid the cluster information dissemination of censored nodes, because low nodes share contact channels with others with cluster routing schemes.

E. Reduction of Delay: In flat routing WSNs, information communication is donestep by step utilized with the method of flooding. In contrast, in clustering based WSNs, only cluster heads execute the challenge of information transmissions from one cluster to another one. This helps to decrease the hops through data source to the BS, due to this it reduces the delay.

## IV. HIERARCHICAL ROUTING

Hierarchical routing makes better energy-efficient routing and scalability at the Wireless Sensor Networks. Hierarchical routing based proceeding network clusters. Cluster head data is selected for processing information such as high strength nodes, CH& the low nodes of energy. It improves lifetime, network scalability. It reduces network traffic [3].

Hierarchical Routing being Classified in the4 Parts as Chain based routing, cluster-based routing, routing of tree-based&grid-based routing as shown in Figure 3.

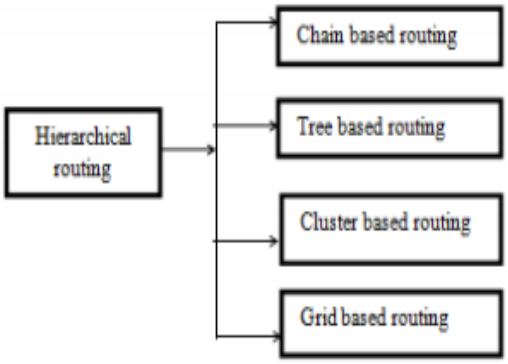


Fig.3 Types of theHierarchical Structure

*A. Chain-based Routing*

In given routing one or more than one chains being madeso as towards associatesensor nodes. After chain single sensor is being madelike the head so as towards executein formation transmission. In Figure 4 sink selected as the head node. Data delivered with the chain & the head node automatically.

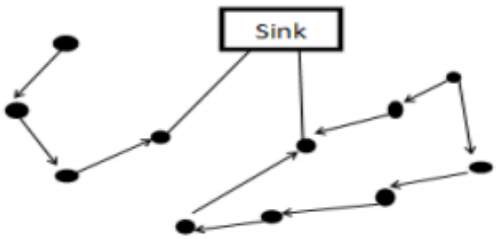


Fig.4 Chain-based Routing

The fundamental disadvantage of chain-based topology that because of at least one chains expands the number of jumps and postponement happened. Part chain based form of routing protocol is proposed where the target system is partitioned into areas. It adjusts nodes in no: and mastermind in the multiple chains. Each chain has assigned a cluster head which reduces energy consumption. It also balances the time length of each round for data transmission. Chain-based routing protocols are:

*1. PEGASIS*

This approach (Power-Efficient Gathering in Sensor Information Systems) is a modification of LEACH. A chain of sensor nodes is formed in which every node trans ferssimply using its adjacent neighbors. Data transmission is done from the node to node & only a designated form of node sends it to the BS. The leader node responsible

for transmission changes turns by turn. The chain formation is either determined by the BS or the nodes themselves from chains using a greedy algorithm, which requires global information of the NW.
While data gathering, every node gathers information after its neighbor and further transmits it to the next neighboring node after fusing it with its own sensed data. To make the scheme robust, the sensor nodes die out at random locations. This is achieved by changing the data transmission leader in each communication round. Nodes having distant neighbors will dissipate more energy. To overcome this, such nodes are allowed to form leaders by setting a threshold on the distance to neighbors. Simulation results demonstrate that PEGASIS outperforms LEACH in many ways viz. dynamic cluster formation overhead is removed, the number of transmissions, a distance of transmission of nodes is minimized, and there is single transmission to the BS in each communication round.

*2. CCS*

As an extension to PEGASIS, CCS (Concentric Clustering Scheme) was proposed by Jung et al. in the year 2007. In this protocol, concentric circles are formed as clusters while the chain is formed according to the PEGASIS protocol. The idea is to remove the redundancy issues in PEGASIS and make the network energy efficient, by considering the location of the BS. Certain level numbers are assigned to each node, which divides the region into concentric circles. The number of levels is determined by the BS depending on node density, location of BS. The lowest level is nearest to BS. Nodes at the same level form a cluster and a chain are formed within each cluster starting from the farthest node to BS. A head node is selected in each cluster or chain. Data transmission within a chain is done in the same manner as in PEGASIS i.e. data is transmitted from the starting node towards its neighbor into the chain and neighbor fuses this data with its own data before transmitting it to its next neighbor until it reaches the head node. Each head node receives data from its chain nodes as well as the head node of the higher level cluster. Finally, all the collected data is transmitted to BS by the head node of the lowest level cluster.

*B. Tree-based Routing Protocols*

In the tree-based routing, the tree is being made throughal together form of sensor nodes into a system. Information conveyed startingthe leaf nodes towards individual parent nodes. Parent node in getting the transfer to data towards its parent hubs. This procedure proceeds to equipped root nodes. It adjusts vigor utilization among the hubs and expands the system lifetime thought about. It's similarto chain-based directing. In any case, the primary disadvantage of this clustering is that it has an excessive number of levels after the root towardsits leaf hubs. Hence it devours much memory aimed at the information transmission.

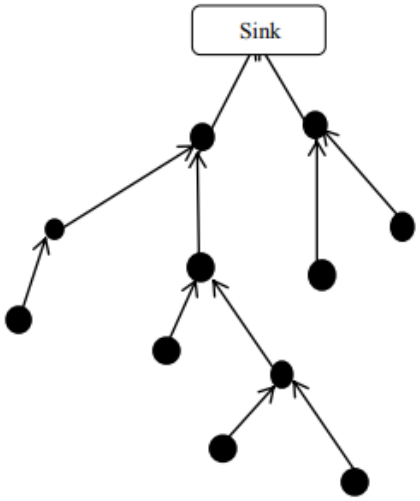


Fig.5 Tree-based Routing

Various forms of tree based on the clustering are:

*1. EADAT*

Energy-Aware Distributed Aggregation Tree performs very well regarding system lifetime, saving energy, information conveyance proportion and the overhead of the protocol. In given, sensors by higher leftover power which have an advanced opportunity towards turn into a non-leaf form of tree node so therefore broaden the lifetime of n/w regarding the number of live nodes. EADAT draws out n/w lifetime, more energy being saved in examination with directing strategies without total. The normal energy dimension of the sensor hubs diminishes considerably more gradually contrasted with the situation without data accumulation. The principle hindrances of EADAT are the broad utilization of clocks and require earlier learning or support from a tree root [4].

*2. PEDAP*

Power Efficient Data Gathering and Aggregation Protocol termed as (PEDAP) is a protocol of Centralized routing. Contrasted with LEACH & PEGASIS, PEDAP accomplishes betterment in the lifetime of the network. The characterized requirement of the sensor nodes is their low limited energy of the battery, which restrains lifetime, nature of n/w. Therefore, conventions running on sensor n/w must devour assets of hubs productively so as to accomplish a more extended n/w lifetime. PEDAP broadens the lifetime of the last hub by limiting complete data assembling in every round whereas PEDAP-PA adjusts vigor utilization in nodes. Edge cost is being registered likethe whole of the communication & getting energy into PEDAP. In PEDAP-PA seeing expense through partitioning PEDAP edge cost byreceiver leftover energy. Impediments of the PEDAP and PEDAP-PA are anyway brought together inside nature. This plan is centering just Shortest Route. It miscarries towards accomplishing Consumption of the Bandwidth i.e. it unfit to get a better form of the Resource Consumption burden; thisis recomputed routing tree soonfrom anassigned no: of rounds. In PEDAP and PEDAP-PA Edge weight task is determined using just transmitters' form of energy of residual form. This is a real downside to make a better form of unwavering quality of the system. [4].

*C. Cluster-based Routing*

Cluster-based routing is progressive routing method. In it,the bunch is shaped through partitioning system in towards gathering of nodes. One hub chose like CH proceeding premise of leftover energy. There are different kinds of the protocols of clustering as per:

*1. LEACH*

The oldest hierarchal protocols, LEACH (Low-Energy Adaptive Clustering Hierarchy) is modest TDMA (Time-Division Multiple Access)-based routing protocol utilized into WSNs. This cluster-based protocol emerged such an energy effectivetransmission protocol aimed at wireless micro-sensor NWs that usesa randomized variation of local cluster BS known as CHstowards uniformly allocate the energy load between sensor nodes intothe network.

The key features of LEACH are:

- Limitedtype of organization& cluster-setupswitch& operation
- Randomized form of rotation of cluster heads & clusters of the corresponding form.
- The local form of compression so as to decrease the global form of communication

LEACH is considered to be a self-organizing form ofthe protocol where the sensor nodes organize by themselves to form clusters and a node is chosen as a CH. The CH work as a local BS in a way that data is transmitted throughevery sensor node towards its corresponding CH. The CHplace is replaced between different sensor nodes in the cluster. LEACH is considered a protocol of form of self-organizing where the sensor nodes being organizedby themselves to form clusters and one node is chosen as a CH. The CH location is being swapped between different sensor nodes inthe cluster to ensure that just a single node does not die out due to loss of its whole energy. The rotation is done in a random manner. The CHs also compresses the data received by it from the other nodes before sending it to the BS to ensure less energy dissipation in N/W. The optimal number of CHs to b elected depends on the network topology or computation cost. CHs are elected within a cluster with a certain probability at different time intervals. The node with higher energy will have higher chances of being a cluster head. Once the CHs are chosen, they broadcast their position or status to a different form of sensor nodes within the network. Each sensor node then calculates the amount of energy essential towards communicatingin formation towards the CHs and chooses the one with minimum. In this method, clusters are being designed. The CHs then create agenda aimed at its sensor nodes towards transmit information and nodes remain turned off until their turn for transmitting data comes. This saves a large amount of energy dissipated usingevery sensor node. After gathering thein formation after every node within the cluster, CH aggregates it and transfer it to BS [3].

*2. HEED*

The fundamental supposition in HEED (Hybrid Energy-Efficient Distributed bunching) is that every sensor node is fit for controlling its transmission power level yet they are area ignorant. This method was created as a circulated and energy proficient cluster development. HEED utilizes a blend of two unique parameters for CH determination, for example, leftover energy of every hub and hub degree. A node can be chosen as a CH relying upon its remaining energy together with some likelihood. The cluster development happens when different nodes in the system pick their individual CHs keeping up least expense of correspondence. The principal target of HEED is to draw out network lifetime just as supporting adaptable information aggregation. At first, the proposed algorithm had the option to assemble just two-level hierarchy [1].

*3. SEP*

The SEP (Stable Election Protocol aimed at clustered heterogeneous Wireless Sensor Networks) was proposed in the year 2004. This technique is an improvement over LEACH and considers two levels of heterogeneity of sensor nodes namely ordinary& progress nodes. Advance nodes are high in energy and have much more probability of becoming CHs as it's compared to the nodes of normal form. The global knowledge of the node energy is not required in every round. Also, the protocol is scalable due to the fact that does not need the position of nodes within the sensor field [1].

*D. Grid-based Routing*

A grid-based routing NW is isolated ina different grid by geographic methodology. Network-based clustering convention utilizes a range of dynamic form which is basedon CH&part of traffic which is avaricious algorithm so as to limit intra cluster correspondence cost. It additionally enhances forwarding cost of inter-cluster packet inside the CH in given routing being performed witha table of routing.

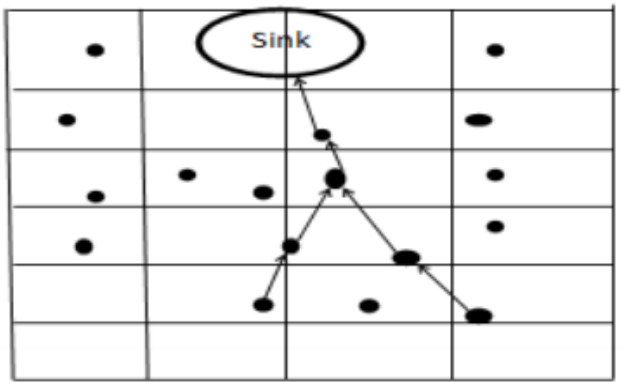


Fig.6 Grid-based Routing

Various routing protocols are as:

*1. PANEL*

PANEL (Position-based Aggregator Node Election scheme) designed to support supports the intra & inter-cluster form of routing permitting the sensor so as towards aggregator, aggregator towards aggregator, BStowards aggregator and aggregator towards BS communications. Aggregators are nodes that collect data from their respective clusters and then store them after aggregation. This technique can be used for synchronous as well as asynchronous WSNs, where the BS receives data after periodic delays. To determine the aggregator nodes, it uses the geographic location of nodes and ensures their selection with nearly equal frequency for load balancing. So, the nodes are static but location aware. The BS is mobile and their presence can be occasional. The cluster size is chosen appropriately according to deployment density and a maximum power range of sensor nodes so that the connectivity within the cluster can be maintained. Each sensor node is connected to every other sensor node within that cluster. This connectivity is used for intra-cluster routing. Anorientationfact is calculated intoevery cluster and node closest towards this reference point is elected as an aggregator. A position-based routing protocol is utilized for inter-cluster transportations. CH is selected at each epoch to ensure load balancing. Reliable and persistent data storage is done by delivering the replicated informationtowards the aggregator node of another cluster [3].

*2. TTDD*

The approach used in TTDD (Two-Tier Data Dissemination) attends multiple mobile BS problems. The sensor nodes are location aware but static and arranged in grids in order to achieve low overhead. The sensor nodes surrounding an area cooperativelyprocedure the signal & one of them develop source node. The source nodes forward their data to other nodes close to the grid points. The BS is mobile and continuously receives data by flooding queries within the same cell and its location is propagated towardseach sensor nodes within the NW so that nodes become aware of the direction for sending data in future. The number of BSs varies from time to time. In this way, TTDD effectively delivers data from multiple sources to multiple BSs with high performance.

*3. HGMR*

HGMR (Hierarchical Geographic Multicast Routing) was introduced in the year 2007. It's a location-based multi-hop routing protocol (multicast) which merges the key design features of previously existing GMR and HRPM techniques in order to overcome the energy inefficiency and scalability issues in large networks. Mobile geographic hashing is used to decompose a multicast group into subgroups. For data transmission, the local multicast scheme is applied. The region of deployment is divided into cells and cost over the progress form of optimizing the broadcast algorithm which is to choose next nodes of the relay at every hop.

## V. LITERATURE SURVEY

This paper [5] proposed two mobility aware leveled grouping of a hierarchical algorithm for the MWSN dependent on 3 layer bunching pecking order; Mobility-mindful Centralized Clustering Algorithm (MCCA) & Mobility-mindful Hybrid Clustering Algorithm (MHCA). Algorithm of MCCA form utilizes brought both gridding at two Clustering layers of progressive system and MHCA algorithm utilizes unified gridding at upper layer as well as conveyed bunching at the lower form ofa layer. The recreation outcome demonstrates that algorithm of proposed work arrange lifetime in better form, lessen energy utilization, balance out group development and upgrade information rates in energy sensor systems. We additionally see that unified Clustering method is better than the mixture Clustering approach.

In work [6] proposed, a dual-hop routing protocol of streamlined formusingthe grid Clustering component is introduced. It is finished throughthe isolating system area in size of uniform type networks where each framework is being deliberatedsuch a group. After every grid, a Grid Head (GH) is designated which is relying on the leftover energy of SNs. The determination of the next-hop for double bounce correspondence depends on discovering the ideal hub from adjoining GHs utilizing methodaimed at Order Inclination through Comparison to Ideal Explanation shortly termed as (TOPSIS) strategy. MATLAB is utilized to play out recreations. Assessment of execution of planned form ofeffort is completed as far as energy utilization, lifespan,& dependability time of NW.

This paper [3] portrays the idea of routing in WSN. Routing algorithm gives a solid way from source to goal. Energy productivity is a fundamental requirement in WSN. For making better lifespan & energy utilization several types of routing algorithm have planned. In given paper depict hierarchical routing methods incorporates tree which is based steering, cluster-based directing, the convention ofa chain based, routing of grid based. And furthermore, think about hierarchical routing.

In this paper [7], creators will give a numerical investigation to compute the ideal cluster measure which isn't explained as of not long ago. Based on the optimum form of cluster measure, Balanced Energy Efficient Grid-based Clustering convention (BEEG) will present. MATLAB will be utilized aimed at assessing the presence of our convention. Reenactment o/c demonstrate proposed BEEG improves system lifetime, having more of the different conventions, for example, LEACH, DCHS, K-LEACH, MOD-LEACH, Energy-LEACH.

In the given article [8], a grid-based dependable multi-bounce approach of routing for WSN is being proposed. So as to limit and adjust energy utilization, our proposed convention, network-based solid multi-jump directing convention, improves the cluster head race process by consolidating singular capacity which comprises of hub's leftover energy and hub's area, and nearby discernment which can adjust energy utilization among clusters by means of a consultative instrument dependent on the lifetime of cluster head's anticipation, while allowing for information sending delay & dependable transmission of information. Recreation results demonstrate that network-based dependable multi-hop routing convention has improved dependability period when contrasted with different conventions. Then, grid-based dependable multi-hop directing convention has efficient execution in the energy productivity, information sending delay, & solid transmission of information.

This paper [9] highlights and discuss the plan difficulties for the cluster based plans, significant cluster arrangement parameters, and characterization of various leveled clustering conventions. Besides, the present cluster based & framework based systems are assessed by thinking about specific parameters so as to help clients in choosing a fitting method. Moreover, a definite outline of these conventions is given their favorable circumstances, drawbacks, and appropriateness specifically cases.

## VI. CONCLUSION

WSN is the resource-constrained & usually operates in the environment of unattended form, soeither replacement of battery else recharging isn’t possible. To use wisely battery source, a different form ofprotocols which is energy efficient been conversed. Out of given energy effective method of structures, schemes which are cluster-based are expected comparatively huge interest as of the significant gains in the whole of then/w lifetime. In most accessible methods, different attempts been made so as to gain energy efficiency duringthe hierarchical form of clustering where the nodes are being gathered in the clusters and information is being furthered through CH towards BS.

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